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EXAMINER

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Please find below and/or attached an Office communication concerning this application or proceeding.

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-3 and 5-8 are rejected under 35 U.S.C. 102(e) as being anticipated by McGrath (US 6,259,795 B1) in view of Mukojima (US 6,418,226 B2).

With respect to claim 1, McGrath discloses a method for positioning of an audio signal comprising: selecting a set of spatial functions, each having an associated scaling factor; providing a first set of amplifiers and a second set of amplifiers, the gains of the amplifiers being a function of the scaling factors (col.5 ln.7-13); receiving a first audio signal (fig.2 #9); providing a direction representing the direction of the source of the first audio signal (fig.2 #11 , col.4 ln.40-50); adjusting the scaling factors depending on the direction (col.5 ln.7-13); applying the first set of amplifiers to the first audio signal to produce first encoded signals (fig.3 #41-44); delaying the first audio signal to produce a delayed audio signal (fig.3 #31 , col.4 ln.57-65); and applying the second set of amplifiers to the delayed audio signal to produce second encoded signals (fig.3 "not labeled").

McGrath does not disclose expressly wherein the first encoded signal is produced to provide a left-channel audio output and wherein the second encoded signal

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is produced to provide a right-channel audio output. McGrath also does not disclose expressly wherein the left-channel audio output excludes the second encoded signals and the right-channel audio output excludes the first encoded signals.

Mukojima discloses a method of positioning a sound image by adjusting scaling factors of an input signal. The method includes separately encoding a first left-channel signal and a second right-channel signal with scaling factors relating to a spatial function directed to a sound source (col.6 ln.18-53). The left-channel output (fig.1 "SOL") excludes the second encoded right-channel signal and the right-channel output (fig.1 "SOR") excludes the first encoded left-channel signal as can be seen in further detail in figure 4.

At the time of the invention it would have been obvious to a person of ordinary skill in the art to use the directional encoding methods of Mukojima in the invention of McGrath. The outputs (McGrath: fig.3 #60-63) of the gain functions (McGrath: fig.3 #41-44) would have been directionally encoded according to a respective right or left-channel, as does Mukojima in figure 4.

The motivation for using the method of Mukojima in the invention of McGrath would have been to give the system a way to individually adjust the spatial characteristics of a channel without affecting the characteristics of the other channel. This could help compensate for users with hearing disabilities or could be used to compensate for a speaker arrangement where a listener is not equidistant from the speakers of the respective right and left-channels.

With respect to claim 2, McGrath discloses the method of claim 1 wherein the spatial functions are spherical harmonic functions (col.4 ln.7-26).

With respect to claim 3, McGrath discloses the method of claim 2 wherein the spherical harmonic functions include at least the first order harmonics (col.4 ln.7-12).

With respect to claim 5, McGrath discloses the method of claim 1 wherein for each of the first and second sets of amplifiers, the gain of each amplifier is based on a B-format encoding scheme (col.5 ln.7-13).

With respect to claim 6, McGrath discloses the method of claim 1 further including: providing a third set of amplifiers and a fourth set of amplifiers, the gains of the amplifiers being a function of the scaling factors (fig.2 #11a, fig.3 #41-44, col.5 ln.7-13); receiving a second audio signal (fig.2 #9a); providing a direction representing the direction of the source of the second audio signal (fig.2 #11a, col.4 ln.40-50); adjusting the scaling factors depending on the direction (col.5 ln.7-13); applying the third set of amplifiers to the second audio signal to produce third encoded signals (fig.3 #41-44); delaying the second audio signal to produce a second delayed audio signal (fig.3 #31, col.4 ln.57-65); applying the fourth set of amplifiers to the second delayed audio signal to produce four encoded signals (fig.3 "not labeled"); mixing the first and the third encoded signals, or the first and the fourth encoded signals (fig.2 #12); and mixing the second and the fourth encoded signals, or the second and the third encoded signals (fig.2 #12).

With respect to claim 7, McGrath discloses the method of claim 6 wherein the second signal is a synthesized audio signal. It is inherent that the encoding of the

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second signal (fig.2 #9a) in the B-Format Determination means (fig.2 #11a) would produce a synthesized signal.

With respect to claim 8, McGrath discloses the method of claim 1 further including: decoding the encoded signals, the decoder comprising filters defined based on the spatial functions (fig.4 #70, col.7 ln.28-58).

Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over McGrath (US 6,259,795 B1) in view of Mukojima (US 6,418,226 B2) and in further view of McGrath et al (US 6,628,787 B1). For convenience the examiner will refer to McGrath (US 6,259,795 B1) as McGrath-A and McGrath et al (US 6,628,787 B1) as McGrath-B.

With respect to claim 4 McGrath-A discloses the method of claim 1, however does not disclose expressly wherein the spatial functions are discrete panning functions.

McGrath-B discloses the use of a panning function in a B-format, 3-D audio reproduction system (col.2 ln.4-25).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to use the panning system of McGrath-B in the B-format processing of McGrath-A.

The motivation for doing so would have been to pan for a first portion of the spatial sound field to a corresponding set of first speaker feeds as determined by the spatial direction as taught by McGrath-B (col.1 ln.42-45).

Claims 20-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over McGrath (US 6,259,795 B1) in view of Gerzon (US 4,086,433).

With respect to claim 20, McGrath discloses a method of producing an audio signal from directionally encoded audio signals comprising: generating a set of spectral functions based on the spatial functions; receiving a first set of directionally encoded audio signals (fig.4 "X", "Z") encoded according to the set of spatial functions; receiving a second set of directionally encoded audio signals (fig.4 "W", "Y") encoded according to the set of spatial functions; providing a first set of decoding filters defined by the set of spectral functions (fig.4 #70); providing a second set of decoding filters defined by the set of spectral functions (fig.4 #76)(col.7 ln.1-16); applying the first set of decoding filters to the encoded audio signals to produce a first set of filtered signals; and applying the second set of decoding filters to the encoded audio signals to produce a second set of filtered signals (fig.5 #8); and providing the first set of filtered signals to a left-channel audio signal and providing the second set of filtered signals to a right-channel audio signal (col.7 ln.24-27).

McGrath does not disclose expressly wherein the left-channel audio signal excludes the second set of filtered signals and the right-channel audio signal excludes the first set of filtered signals.

Gerzon discloses a method of decoding signals wherein the left-channel audio signals (fig.8 "LBU", "LFU", "LBD", "LFD") exclude the second set of filtered signals (fig.8 "W", "Y") and the right-channel audio signals (fig.8 "RFU", "RBU", "RFD", "RBD") exclude the first set of filtered signals (fig.8 "X", "Z").

At the time of the invention it would have been obvious to a person of ordinary skill in the art to use the decoder of Gerzon in the invention of McGrath.

The motivation for doing so would have been to reproduce the B-format encoded signals on an eight channel stereo system. This would provide a user with a more accurate representation of a three-dimensional sound field.

With respect to claim 21, McGrath discloses the method of claim 20 wherein the set of spatial functions is defined by $\{g_i(\theta, \phi), i = 0, 1, \dots, N-1\}$ and generating the spectral functions includes providing $L_i(f)$ and $R_i(f)$ such that $\sum g_i(\theta, \phi)L_i(f)$ approximates $\underline{L}(\theta, \phi, f)$ (McGrath $h_{j,R(i)}$) and $\sum g_i(\theta, \phi)R_i(f)$ approximates $\underline{R}(\theta, \phi, f)$ (McGrath $h_{j,L(i)}$) where $\underline{L}(\theta, \phi, f)$ is a set of left ear HRTFs and $\underline{R}(\theta, \phi, f)$ is a set of right ear HRTFs, where $\{(\theta_p, \phi_p), p = 1, 2, \dots, P\}$ is a set of directions and f is frequency (col.8 ln.3-20).

With respect to claim 22, McGrath discloses the method of claim 21 wherein $\underline{L}(\theta, \phi, f)$ and $\underline{R}(\theta, \phi, f)$ are delay-free HRTFs (fig.5 #6). The use of the mixer in the McGrath reference supplies a delay free HRTF to the system before the signal is delayed in the FIR filters (fig.5 #8).

With respect to claim 23, McGrath discloses the method of claim 21 wherein providing $L_i(f)$ includes solving, at each frequency f , the vector equation $\underline{L} \cong \underline{G}\underline{L}$ (col.6 ln.41-45),, where: the set of left ear HRTFs $\underline{L}(\theta, \phi, f)$ define a $P \times 1$ vector \underline{L} , \underline{G} is a $P \times N$ matrix whose columns are $P \times 1$ vectors $G_i, i = 0, 1, \dots, N-1$ each of the N spatial functions $g(\theta_p, \phi_p)$ defines the vector G_i , and the set of $L_i(f)$ defines the $N \times 1$ vector \underline{L} (col.6 ln.12-25).

With respect to claim 24, McGrath discloses the method of claim 23 wherein providing $L_i(f)$ is obtained by pseudo-inversion of the matrix G , resulting in $L = (GTG)^{-1}GT\underline{L}$ (col.6 ln.50-55).

With respect to claim 25, McGrath discloses the method of claim 24 wherein providing $L_i(f)$ includes projecting a $P \times 1$ vector \underline{L} formed by the set of left ear HRTFs $\underline{L}(\theta, \phi, f)$ over each of the $P \times 1$ vectors G_i formed by the spatial functions $g(\theta_p, \phi_p)$ to compute the scalar product L_i (col.6 ln.40-55).

With respect to claim 26, McGrath discloses the method of claim 25 wherein an $N \times 1$ vector L formed by the scalar products L_i is multiplied by the inverse of the Gram matrix GTG (col.6 ln.50-55).

With respect to claim 27, McGrath discloses the method of claim 23 wherein providing $L_i(f)$ is obtained by $L = (GT\Delta G)^{-1}GT\underline{L}$ where Δ is a diagonal $P \times P$ matrix where the P diagonal elements are weights applied to the individual directions (θ_p, ϕ_p) , $p = 1, 2, \dots, P$ (col.6 ln.46 –62).

With respect to claim 28, McGrath discloses the method of claim 27 where each weight (col.6 ln.56-62) is proportional to a solid angle associated with the corresponding direction (col.5 ln.58-64, col.6 ln.12-25).

With respect to claim 29, McGrath discloses the method of claim 20 wherein the spatial functions are spherical harmonic functions (col.4 ln.7-26).

With respect to claim 30, McGrath discloses the method of claim 29 wherein the spherical harmonic functions include at least zero- and first- order harmonics (col.4 ln.7-12).

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With respect to claim 31, McGrath discloses the method of claim 30 wherein the spectral functions define filters $L_w(f)$, $L_x(f)$, $L_y(f)$, and $L_z(f)$ (fig.4 #70), effective for decoding binaural B-format encoded signals WL, XL, YL, ZL, WR, XR, YR, and ZR, wherein the left channel audio signal is defined by $WLLW(f) + XLLx(f) + YLLy(f) + ZLLz(f)$ (fig.4 #73) and the right channel audio signal is defined by $WRLw(f) + XRLx(f) - YRLy(f) + ZRLz(f)$ (fig.4 #74, col.10 ln.27-33); whereby the left and right channel audio signals are suitable for playback with headphones (col.8 ln.27-38).

With respect to claim 32, McGrath discloses the method of claim 30 wherein the spectral functions define filters $L_w(f)$, $L_x(f)$, $L_y(f)$, and $L_z(f)$ (fig.4 #70,76,) effective for decoding binaural B-format encoded signals WL, XL, YL, ZL, WR, XR, YR, and ZR (fig.4 #71,72).

McGrath does not disclose expressly wherein the left audio signal comprises two signals and wherein the right audio signal comprises two signals.

The Gerzon reference discloses sound reproduction system wherein the left audio signal comprises two signals, a first signal $L_b = 0.5(W_d - X_d + Y_d)$ and a second signal $L_f = 0.5(W_d + X_d + Y_d)$ and the right audio signal comprises two signals, a first signal $R_f = 0.5(W_d + X_d - Y_d)$ and a second signal $R_b = 0.5(W_d - X_d - Y_d)$ (col.5 ln.12-19); whereby the left and right channel audio signals are suitable for playback over a pair of front speakers and a pair of rear speakers (fig.1).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to split the amplitude of the left and right audio signals of the McGrath reference in order to feed front and back speakers as in the Gerzon reference.

The motivation for doing so would have been to create a three-dimensional sound for multiple listeners without the use of headphones.

Claims 33 and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over McGrath (US 6,259,795 B1) in view of Gerzon (US 4,086,433) as applied to claim 32 above, and further in view of Clemow (US 6,577,736 B1).

With respect to claim 33, McGrath in view of Gerzon discloses the method of claim 32, however does not disclose expressly wherein cross-talk cancellation is performed on the front and rear speakers.

Clemow discloses performing a first cross-talk cancellation on the LF and RF signals to feed the front speakers; and performing a second cross-talk cancellation on the LB and RB signals to feed the rear speakers (fig.8 "TCC - Transaural Crosstalk Cancellation", col.1 ln.39-57).

At the time of the invention it would have obvious to a person of ordinary skill in the art to have performed Clemow's cross-talk cancellation on the audio signals of Gerzon.

The motivation for doing so would have been to eliminate cross-talk between the signals of the front and rear speakers.

With respect to claim 37, McGrath discloses the method of claim 33 in view of Gerzon and Clemow, however does not disclose expressly wherein cross-talk cancellation is performed on the left and right audio signals.

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Clemow discloses an audio reproduction system including performing crosstalk cancellation of the left and right audio signals before feeding the loudspeakers (fig.5)

At the time of the invention it would have obvious to a person of ordinary skill in the art to have performed Clemow's cross-talk cancellation on the audio signals of Gerzon.

The motivation for doing so would have been to eliminate cross-talk between the left and right audio signals.

Claims 34-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over McGrath (US 6,259,795 B1) in view of Gerzon (US 4,086,433) and in further view of McGrath et al (US 6,628,787 B1). For convenience the examiner will refer to McGrath (US 6,259,795 B1) as McGrath-A and McGrath et al (US 6,628,787 B1) as McGrath-B.

With respect to claim 34 McGrath-A discloses the method of claim 20, however does not disclose expressly wherein the spatial functions are discrete panning functions.

McGrath-B discloses the use of panning functions in an audio reproduction system wherein the panning functions have a direction, called a principal direction, where the spatial function is maximum and wherein all other spatial functions are zero (col.3 ln.13-36).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to use the panning system of McGrath-B in the B-format processing of McGrath-A.

The motivation for doing so would have been to pan for a first portion of the spatial sound field to a corresponding set of first speaker feeds as determined by the spatial direction as taught by McGrath-B (col.1 ln.42-45).

With respect to claim 35 McGrath-A discloses the method of claim 34 in view of McGrath-B, wherein the spectral function associated with each spatial function is the delay-free HRTF for the corresponding principal direction (McGrath-A fig.5 #6). The use of the mixer in the McGrath reference supplies a delay free HRTF to the system before the signal is delayed in the FIR filters (McGrath-A fig.5 #8).

With respect to claim 36 McGrath-A discloses the method of claim 34 in view of McGrath-B, however does not disclose wherein the spatial function has a principal direction.

McGrath-B discloses an audio reproduction system wherein one or more of the spatial functions have their principal direction corresponding to a direction of one of the loudspeakers (col.2 ln.21-25).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to have the principal direction of the panning function of McGrath-B in the direction of the sound source of McGrath-A.

The motivation for doing so would have been to provide an accurate direction of the sound source where the primary direction of the panning function would be concentrated on the source of the desired sound.

Claims 38, 39 and 40 are rejected under 35 U.S.C. 103(a) as being unpatentable over McGrath (US 6,259,795 B1) in view of McGrath et al (US 6,628,787 B1) and Gerzon (US 4,086,433) as applied to claim 34 above, and further in view of Clemow (US 6,577,736 B1).

With respect to claim 38, McGrath-B discloses the method of claim 34, however does not disclose expressly wherein the method includes producing front and back audio signals.

Clemow discloses an audio reproduction system that produces left-front and left back signals based on the left channel audio signal (col.5 ln.58-67, col.6 ln.1-19); producing right-front and right-back signals based on the right-channel audio signal; and combining the left-front, left-back, right-front, and right-back signals to produce outputs suitable for playback with a pair of front speakers (fig.5 #22a,22b) and a pair of rear speakers (fig.5 #22c,22d).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to split the left and right audio signals of McGrath-B to produce front and back signal as in the system of Clemow.

The motivation for doing so would have been to create a three-dimensional sound for multiple listeners without the use of headphones.

With respect to claim 39, McGrath-A discloses the method of claim 38 in view of Clemow and McGrath-B, however does not disclose expressly the use of cross-talk cancellation on the front and back speakers.

Clemow discloses performing a first cross-talk cancellation on the LF and RF signals to feed the front speakers; and performing a second cross-talk cancellation on the LB and RB signals to feed the rear speakers (fig.8 "TCC - Transaural Crosstalk Cancellation", col.1 ln.39-57).

At the time of the invention it would have obvious to a person of ordinary skill in the art to have performed Clemow's cross-talk cancellation on the audio signals of McGrath-A.

The motivation for doing so would have been to eliminate cross-talk between the signals of the front and rear speakers.

With respect to claim 40 McGrath-A discloses the method of claim 39 in view of Clemow, however does not disclose expressly wherein the spatial functions have a principal direction corresponding to the direction of the loudspeakers.

McGrath-B discloses the use of panning functions in an audio reproduction system wherein the panning functions have a principal direction corresponding to the direction of the loudspeakers (col.2 ln.21-25).

At the time of the invention it would have been obvious to a person of ordinary skill in the art to have the principal direction of the panning function of McGrath-B in the direction of the sound source of McGrath-A.

The motivation for doing so would have been to provide an accurate direction of the sound source where the primary direction of the panning function would be concentrated on the source of the desired sound.

Response to Arguments

Applicant's arguments with respect to claims 1 and 20 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jason R. Kurr whose telephone number is (571) 272-0552. The examiner can normally be reached on M-F 10:00am to 6:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vivian Chin can be reached on (571) 273-8300. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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